CERES Energy Balanced and Filled (EBAF) Edition4 Plans

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EBAF Ed2.8 (Current Version)

- Essentially a hybrid of:
  - Clouds & ADMs used in CERES SSF Ed2 (same as Ed3)
    => GEOS 4 (03/2000-12/2007), GEOS 5.2.1 (01/2008-)
    => MODIS Collection 4 (03/2000-04/2006) & 5 (05/2006-)
  - TOA fluxes determined using Ed3 calibration coefficients

- While input changes have minimal impact on all-sky TOA fluxes, they cause discontinuities in clear-sky TOA fluxes (through scene identification) and all-sky and clear-sky surface radiative fluxes.

- Consequently, there's a spurious trend in TOA Cloud Radiative Effect.

- EBAF-SFC makes adjustments to minimize impact of input changes.

EBAF Ed 4.0 (Future Version)

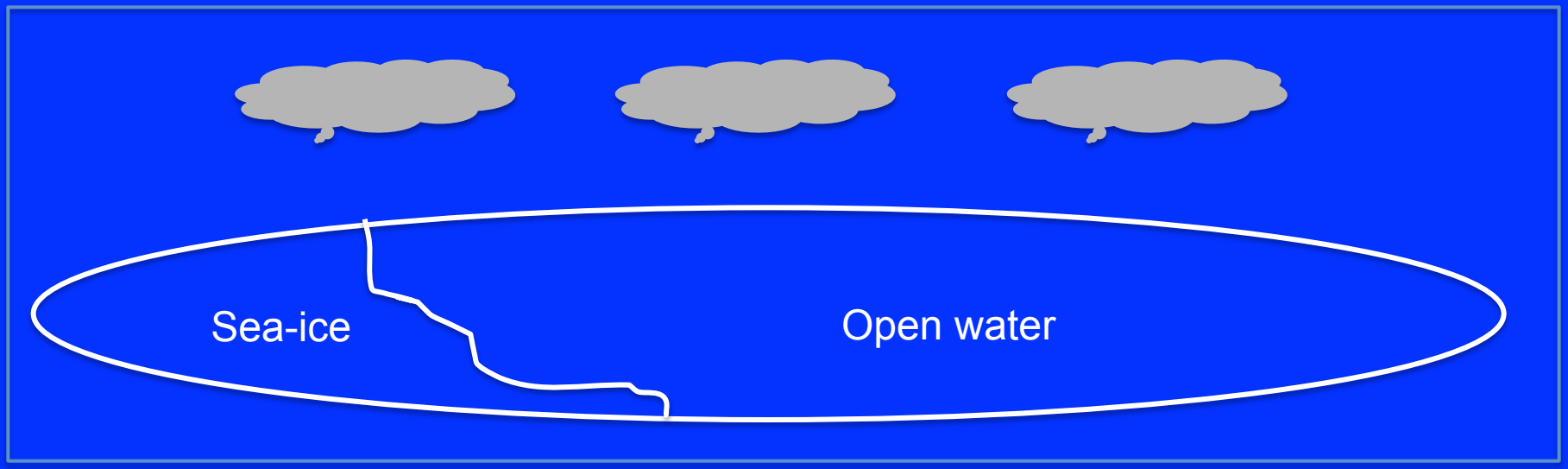
- Will incorporate all of the Ed4 algorithm improvements:
  - Improved instrument calibration
  - Cloud properties
  - ADMs
  - Surface flux calculations
  - Time Interpolation and Space Averaging (with hourly GEOs)
  - Will be based upon consistent met assimilation (GEOS 5.4.1), MODIS radiances and aerosols (Collection5, until that gets superseded by C6)
- Will incorporate refinements to the EBAF high-resolution clear-sky TOA fluxes, particularly for footprints with snow & sea-ice.
  - New narrow-to-broadband regressions (use more MODIS bands & Ed4.0 CERES radiances)
  - Estimate clear-sky fluxes for footprints with partial snow and sea-ice coverage.
- TOA fluxes will be constrained using same approach as EBAF Ed2.8 (Argo constraint).

- Plan is to initially release 5 years (2005-2010) by early 2016.
- EBAF Ed2.8 will continue to be produced until EBAF Ed4.0 catches up.

EBAF Clear-Sky TOA Radiative Flux: (Very) Preliminary Results

- EBAF includes clear-sky fluxes from cloud-free CERES footprints & estimates from clear portions of partly cloudy CERES footprints.
- Here we show expected differences between clear-sky TOA fluxes in EBAF Ed4.0 and EBAF Ed2.8
- Estimated using data in Ed3 SSF and new Ed4 SSF for Terra
  - Differences due to:
    - Different MODIS cloud mask, ADMs
    - Use of additional MODIS channels in narrow-to-broadband regression
    - Inclusion of footprints partly covered by snow or sea-ice.
- Convert gridded instantaneous differences to 24-h averages using TISA code employed in EBAF Ed2.8.
- Caution: These are only estimates—not all steps in EBAF process are included here.

Clear-sky Flux for Partly Cloudy Footprints with Partial Snow/Sea-ice Cover



EBAF Ed2.8 (Method 1)

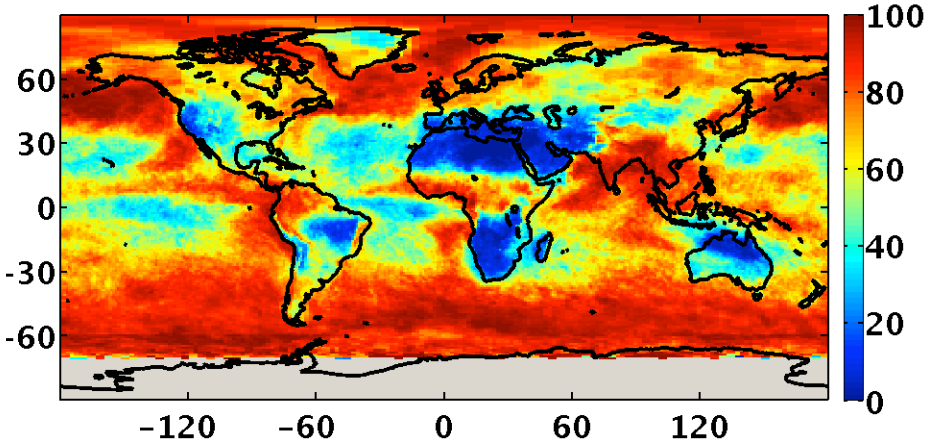
- MODIS/CERES regressions uses only 5 MODIS channels available in Ed3 SSF.
- Only estimate high-resolution clear-sky flux if FOV is partly cloudy and has 100% sea-ice, 100% open water or 100% land coverage.

EBAF Ed4.0 (Method 2)

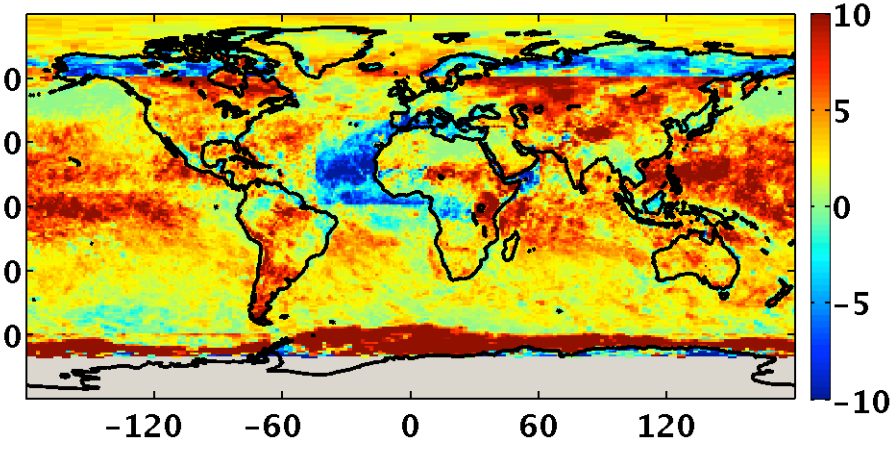
- MODIS/CERES regression uses many more MODIS channels available in Ed4 SSF.
- Estimate high-resolution clear-sky flux if FOV is partly cloudy and partly sea-ice/ water or partly snow/land. Apply both sets of regressions to clear-sky radiances and weight by surface type coverage.

Daytime Cloud Fraction: Ed4 vs Ed3 (200407)

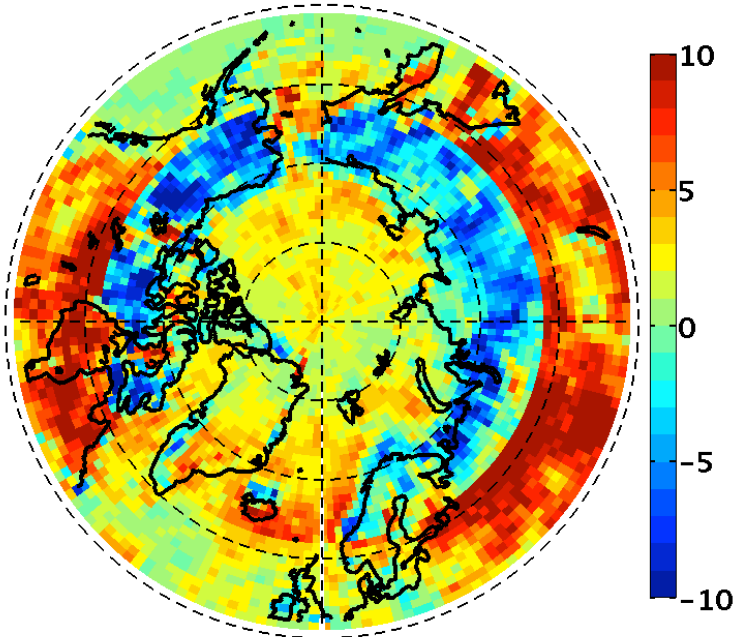
Mean Ed4 Cloud Fraction (Glob Mn = 66%)



Ed4 minus Ed3 (Glob Mn = 3.1%)



Ed4 minus Ed3 (Glob Mn = 3.1%)



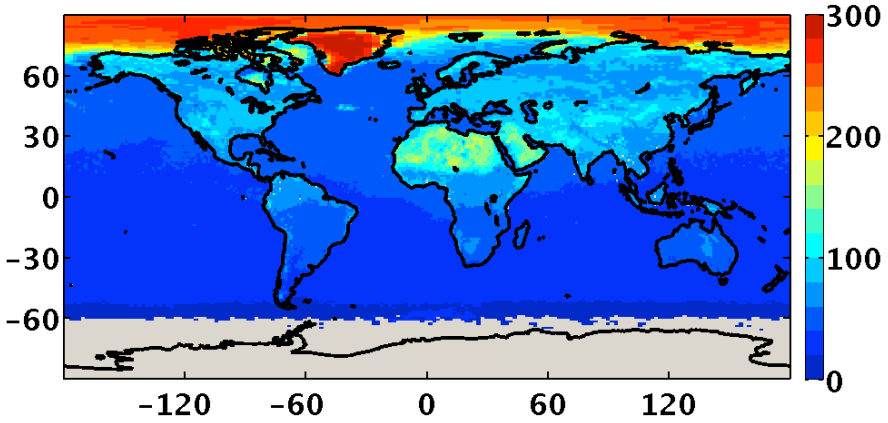
- Increase in cloud fraction in Ed4 everywhere except west of Saharan Desert & over land north of 60°N.

  -> Ed4 corrects misclassification of dust as cloud in Ed3.

  -> Known discontinuity at 60°N in Ed3 from switch between daytime & nighttime cloud mask.

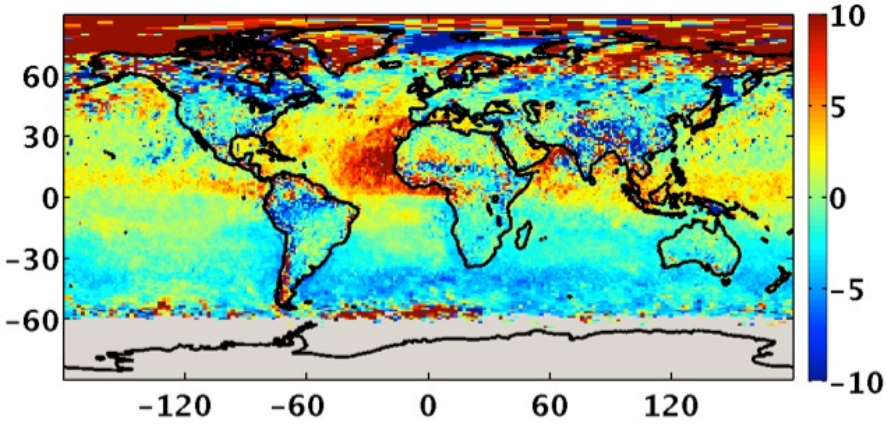
Estimated EBAF High-Resolution Clear-Sky SW TOA Flux Diff (200407)

Mean Ed4.0 (Method 2)



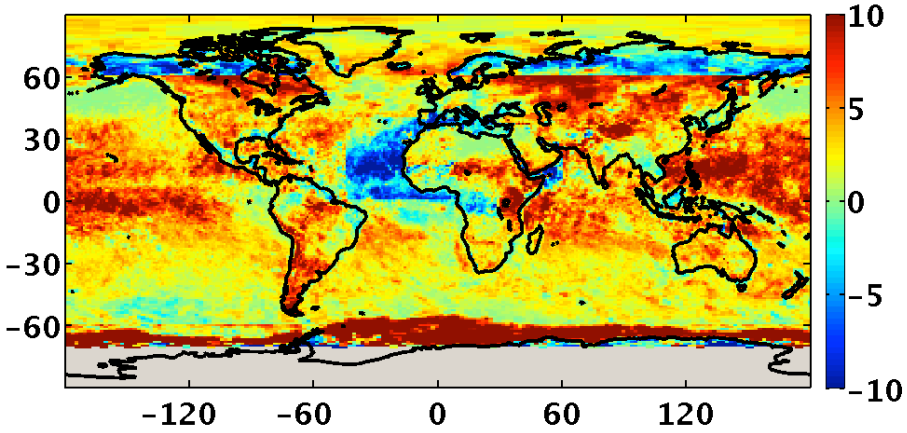
Global mean = 52.5 Wm^{-2}

Ed4.0 (Method 2) minus Ed2.8



Global mean = 0.97 Wm^{-2}

Ed4 minus Ed3 Cloud Fraction

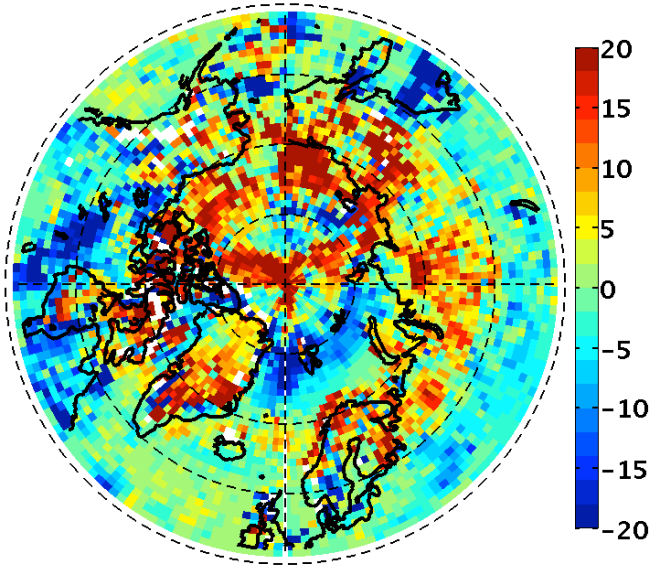


Global mean Diff = 3.1%

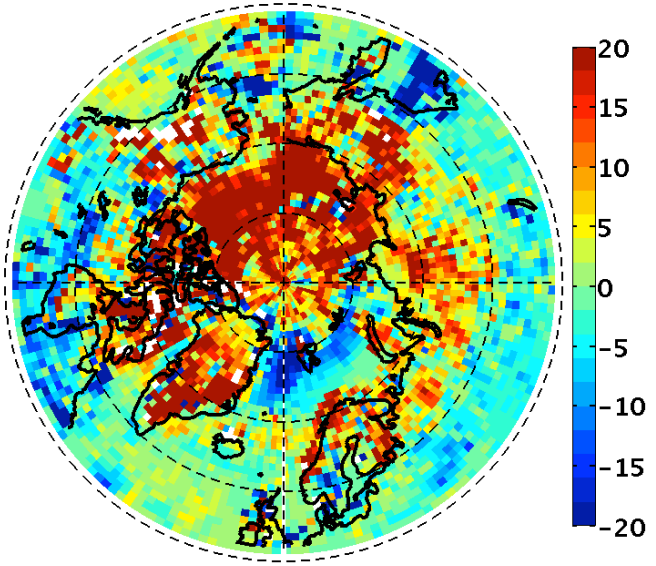
- Increases of 10 Wm^{-2} or more for Saharan dust over ocean.
- Decreases of up to 5 Wm^{-2} over Southern Oceans

Estimated EBAF High-Resolution Clear-Sky SW TOA Flux Diff (200407)

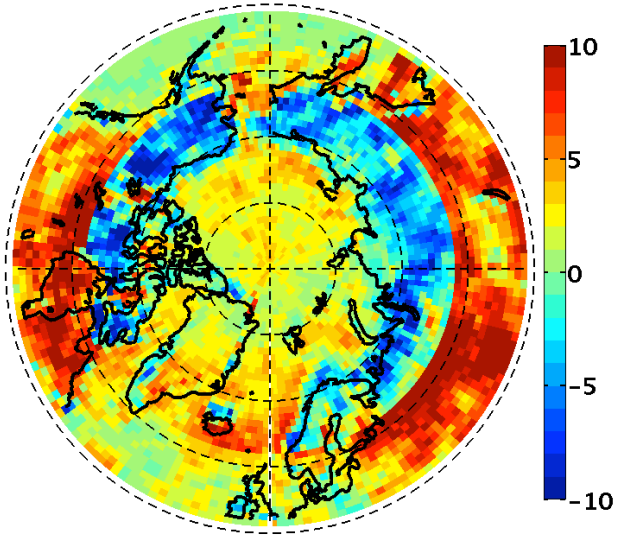
Ed4.0 (Method 1) minus Ed2.8



Ed4.0 (Method 2) minus Ed2.8



Ed4 minus Ed3 Cloud Fraction

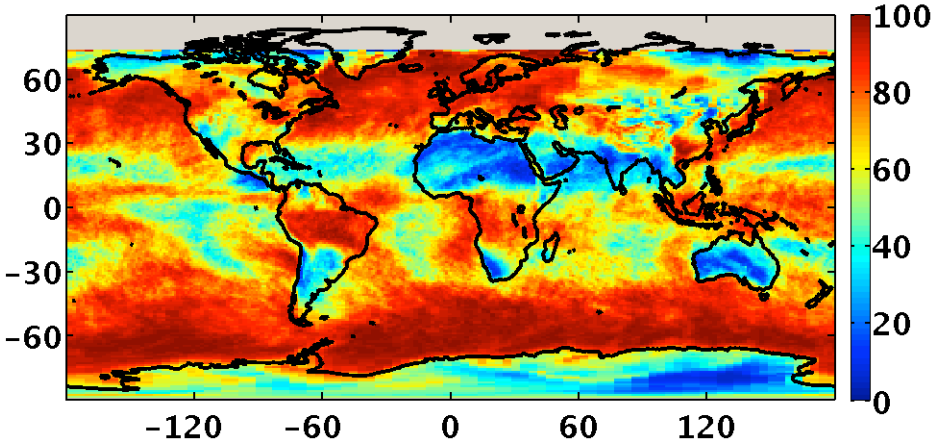


- Inclusion of partly cloudy FOVs with partial sea-ice coverage increases clear-sky SW TOA flux over Arctic Ocean.

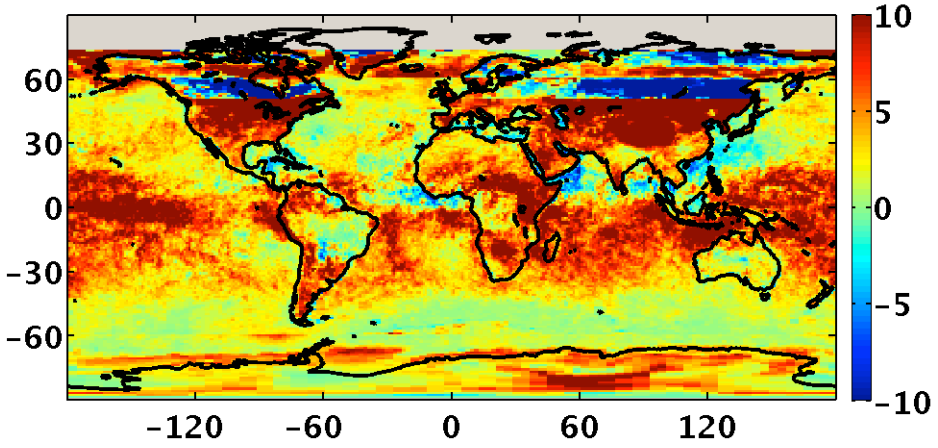
  -> Ed2.8 excluded many FOVs with high partial sea-ice coverage.

Daytime Cloud Fraction: Ed4 vs Ed3 (200401)

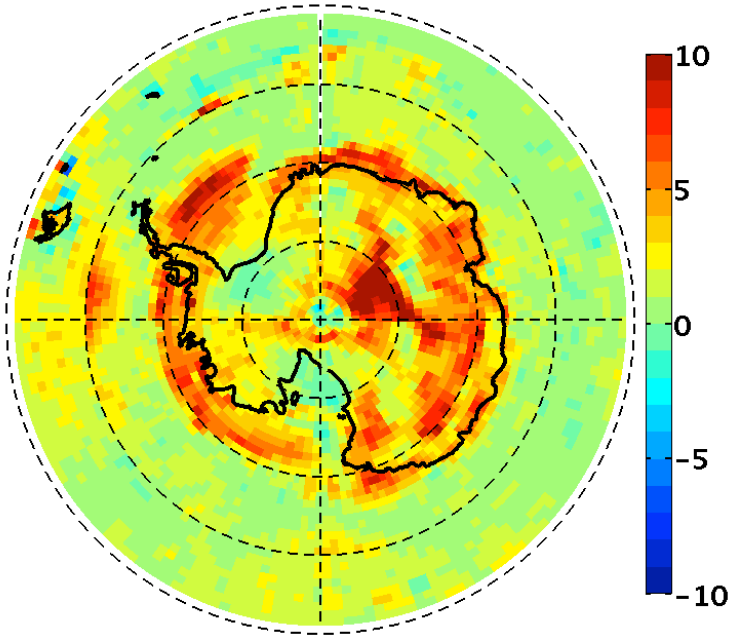
Mean Ed4 Cloud Fraction (Glob Mn = 67%)



Ed4 minus Ed3 (Glob Mn = 4.4%)



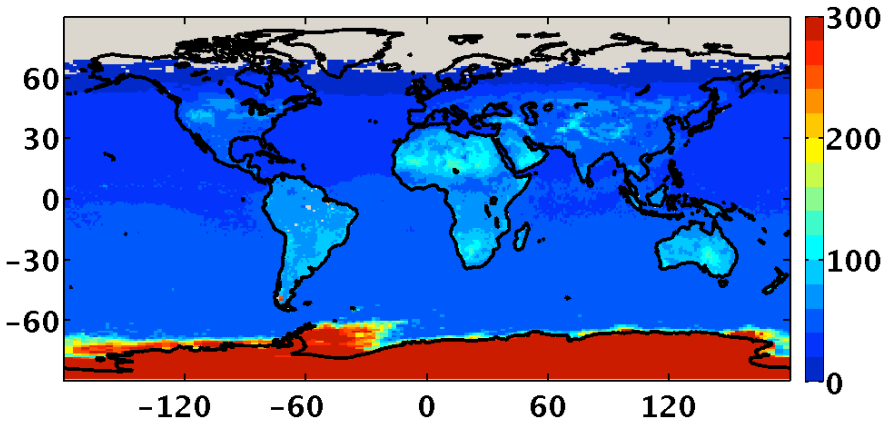
Ed4 minus Ed3 (Glob Mn = 3.1%)



- Increase in cloud fraction in Ed4 greatest for ocean 0°-30°S and NH midlatitude land sourth of 60°N.

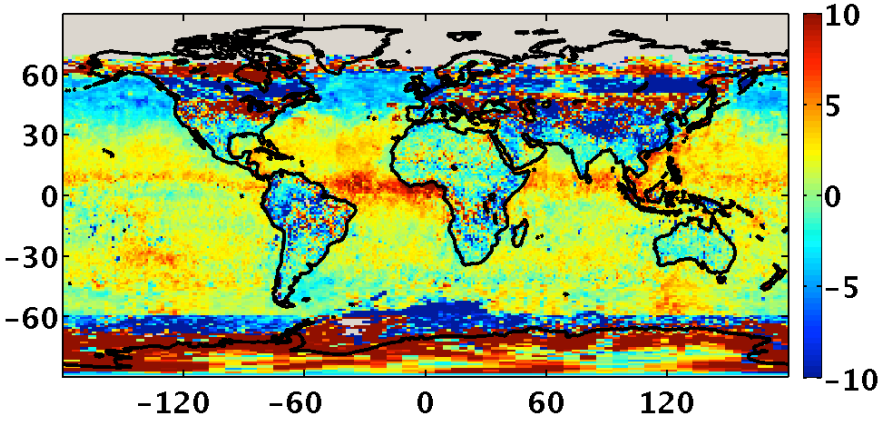
Estimated EBAF High-Resolution Clear-Sky SW TOA Flux Diff (200401)

Mean Ed4.0 (Method 2)



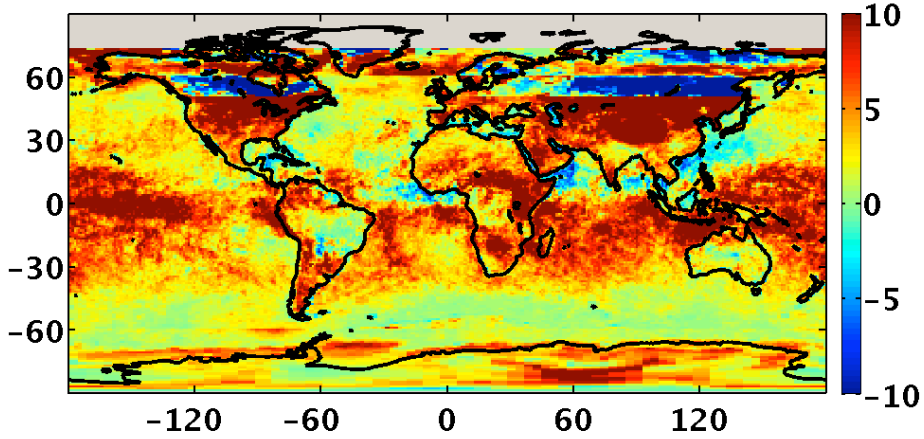
Global mean = 55.9 Wm^{-2}

Ed4.0 (Method 2) minus Ed2.8



Global mean = 1.6 Wm^{-2}

Ed4 minus Ed3 Cloud Fraction

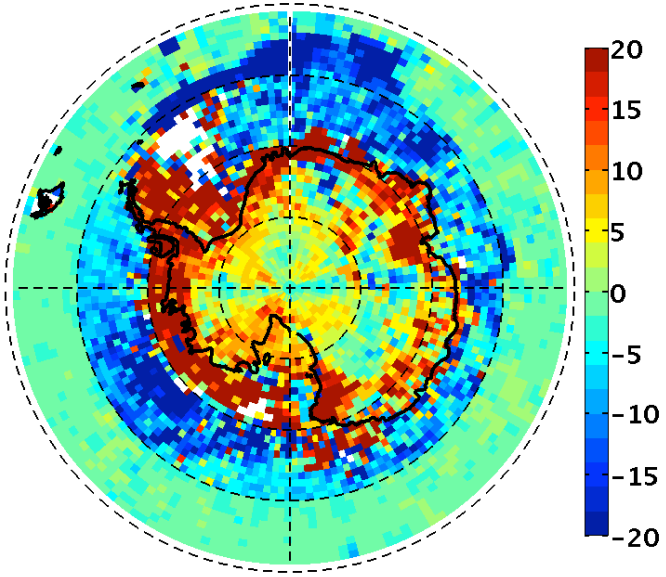


Global mean Diff = 3.1%

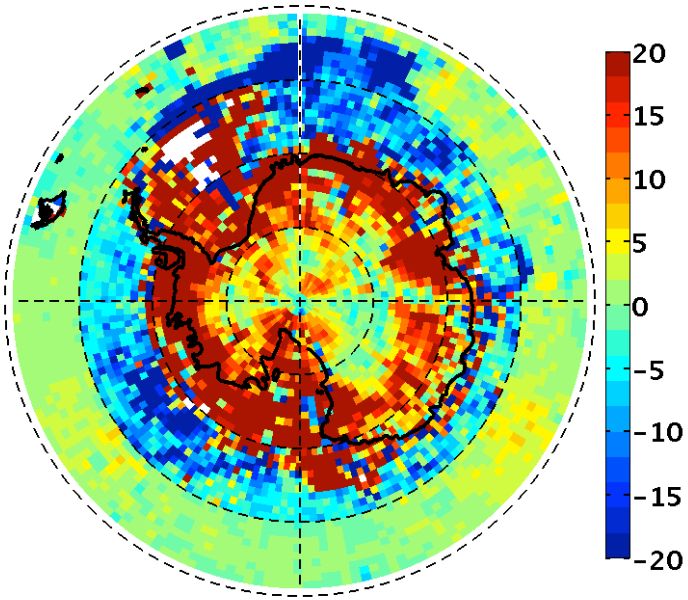
- Clear-sky SW TOA flux differences generally positive over ocean and negative over land.

Estimated EBAF High-Resolution Clear-Sky SW TOA Flux Diff (200401)

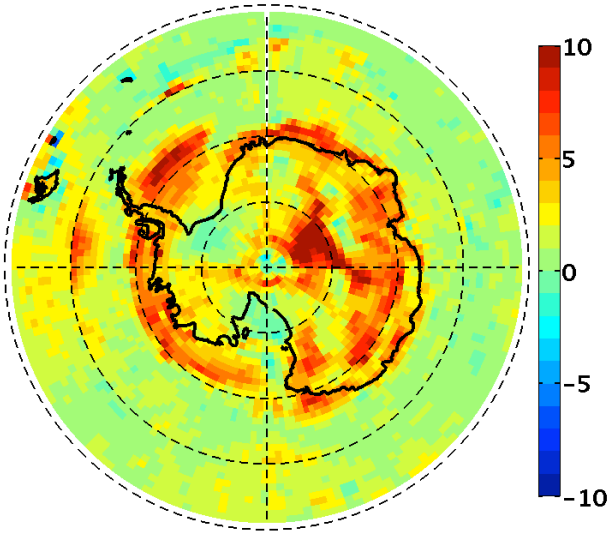
Ed4.0 (Method 1) minus Ed2.8



Ed4.0 (Method 2) minus Ed2.8



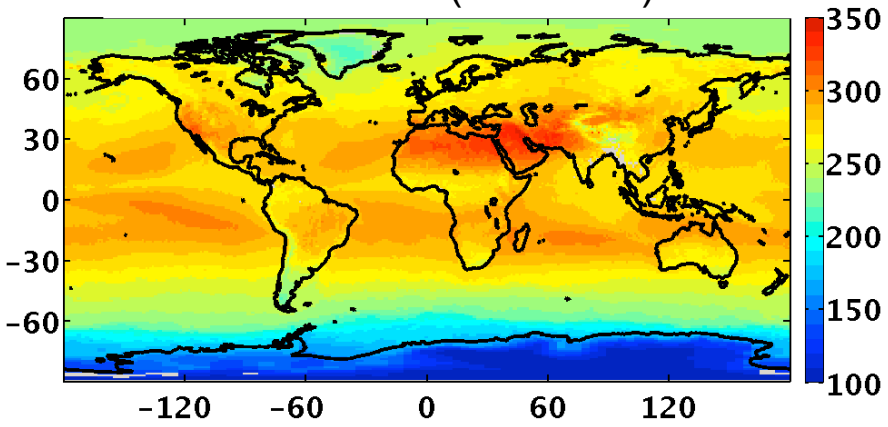
Ed4 minus Ed3 Cloud Fraction



- Larger difference in Ed4.0 (Method 2) compared to Ed4.0 (Method 1) over permanent snow due to a code change to correct diurnal model specification (i.e., bug fix).

Estimated EBAF High-Resolution Clear-Sky LW TOA Flux Diff (200407)

Estimated Ed4.0 (Method 2)



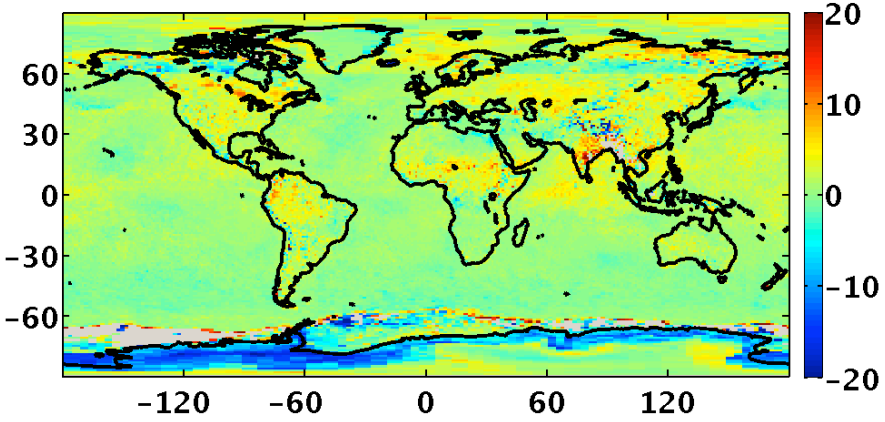
Global mean = 268.7 Wm^{-2}

Caution:

- Impact of new NB2BB is likely overestimated here since not all steps in EBAF clear-sky flux determination are considered here.

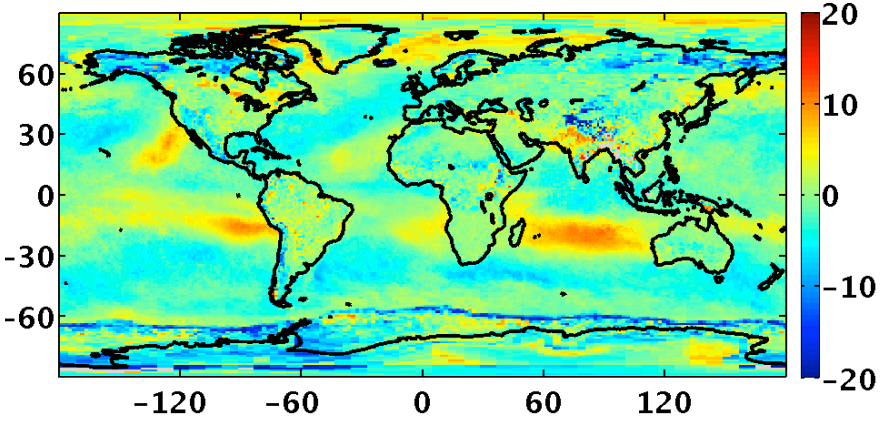
=> NB2BB bias correction against CERES clear-sky flux

Estimated Ed4.0 (Method 1) minus Ed2.8



Global mean Diff = 1.5 Wm^{-2}

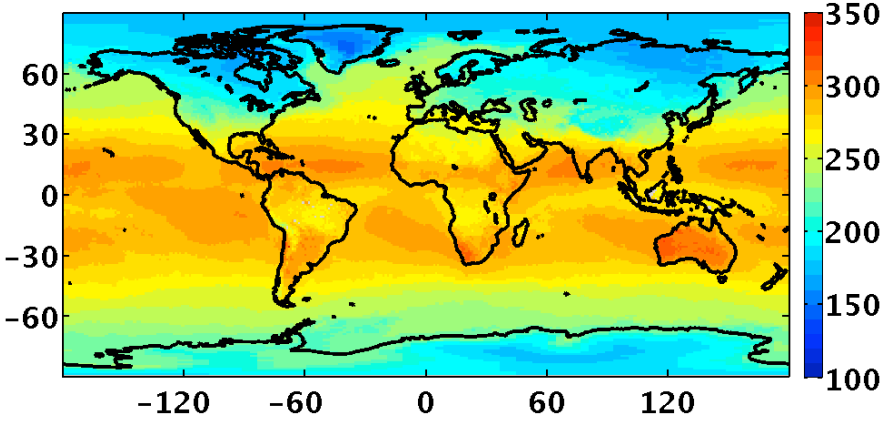
Estimated Ed4.0 (Method 2) minus Ed2.8



Global mean Diff = -1.1 Wm^{-2}

Estimated EBAF High-Resolution Clear-Sky LW TOA Flux Diff (200401)

Estimated Ed4.0 (Method 2)



Global mean = 261.8 Wm^{-2}

Caution:

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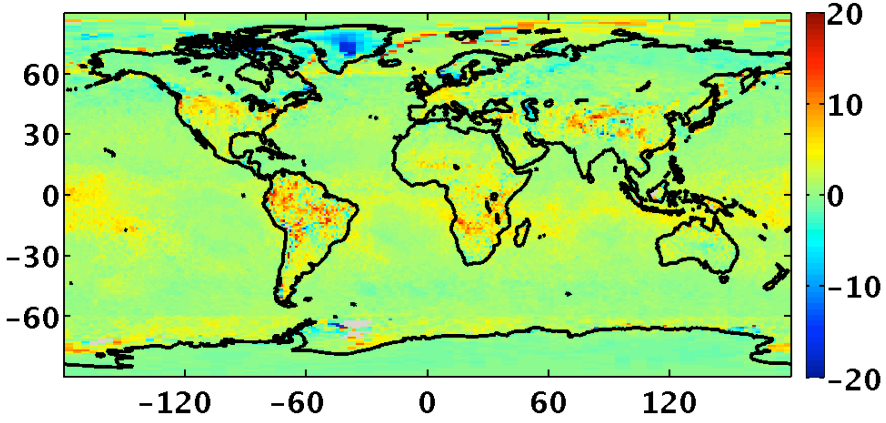
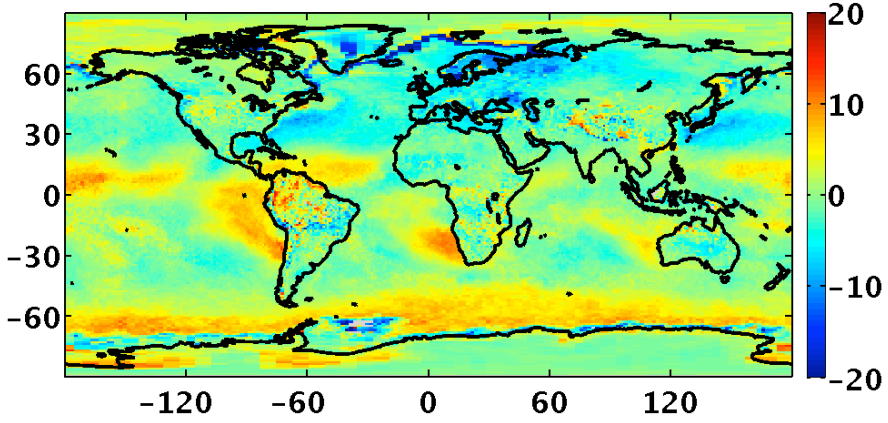
=> NB2BB bias correction against CERES clear-sky flux

Estimated Ed4.0 (Method 1) minus Ed2.8



Global mean Diff = 1.4 Wm^{-2}

Estimated Ed4.0 (Method 2) minus Ed2.8

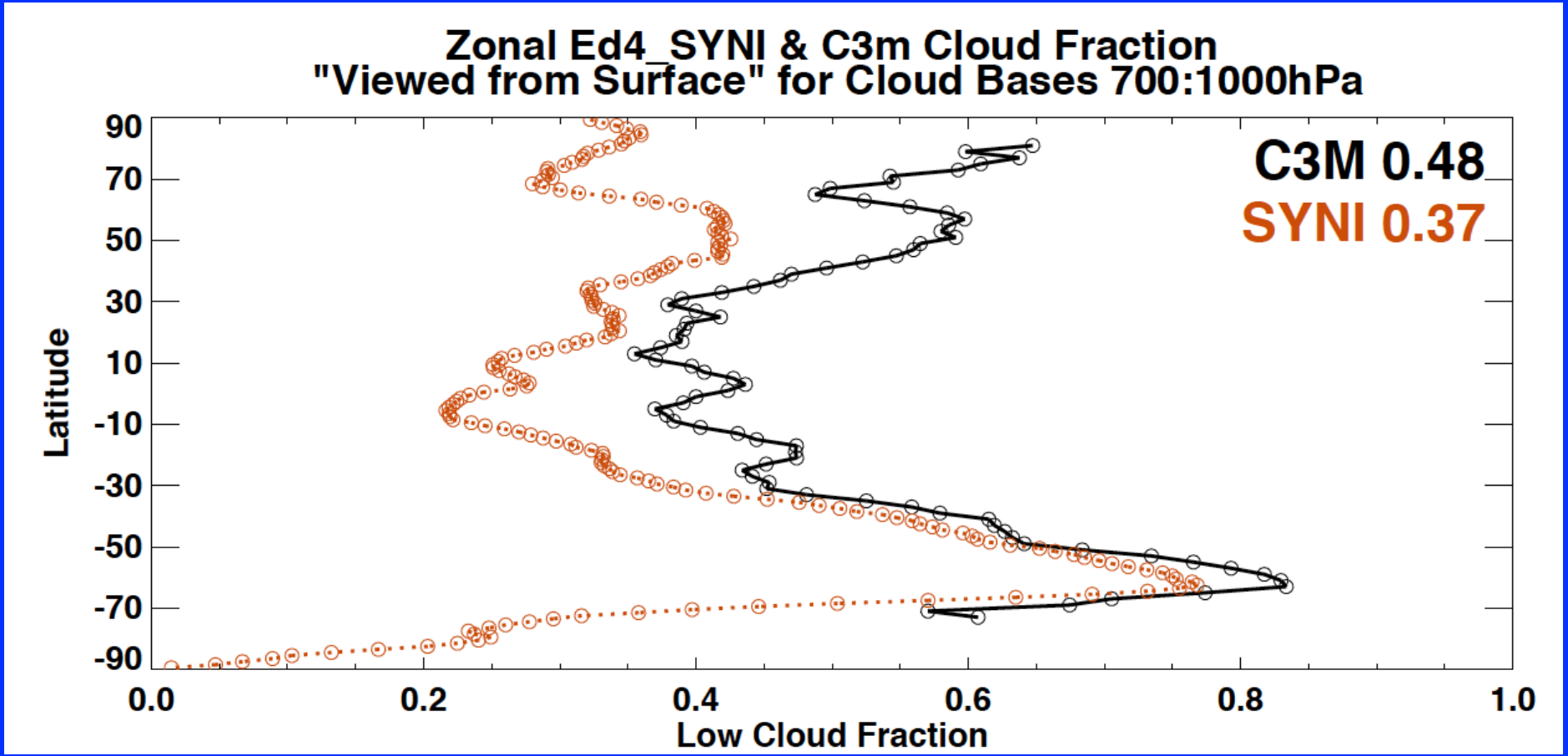


Global mean Diff = 0.2 Wm^{-2}

EBAF-surface (Ed4)

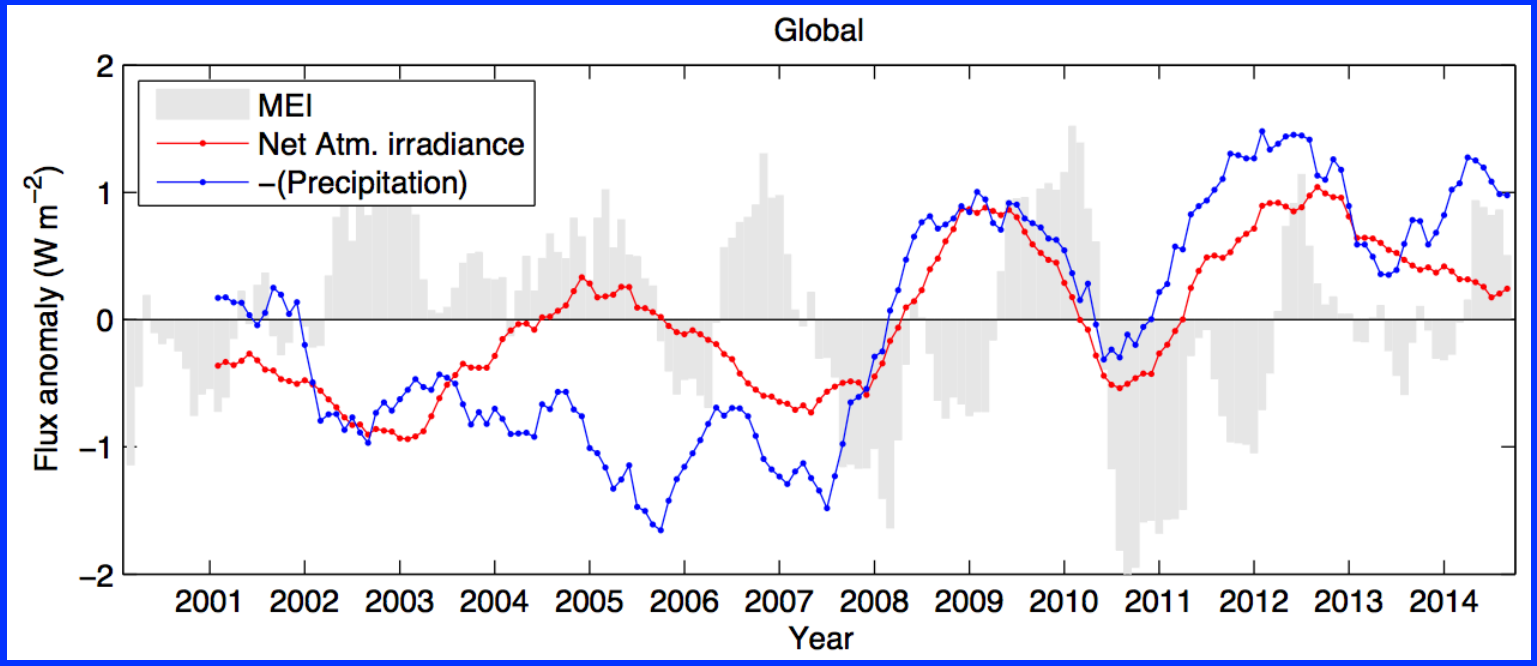
- Revise the bias correction of downward longwave because Ed 4 SYN accounts for cloud overlap
  - Bias correction is based on cloud overlap comparison using Ed4 SYN and CALIPSO and CloudSat (C3M).
- Revise the bias correction of OLR with AIRS v006 because reanalysis is switched to GEOS-5.4.1
  - Bias error estimate is based on upper tropospheric relative humidity comparison with AIRS, MERRA2, and ERA-Interim
- Test a possible use of spectral radiances for T and Q adjustments.
- Revise the uncertainty estimate used for Lagrange multiplier algorithm.
- Estimate uncertainty in surface radiative fluxes
  - Comparison with surface observations
  - Evaluation of surface radiative flux variability
  - Surface and atmospheric energy balance check

Low-level cloud fraction comparison (Jan. 2010)



- Cloud fraction and base height difference will be converted to the downward longwave irradiance change.
- The longwave irradiance change will be used for the bias correction

Atmospheric net radiative flux (SW+LW) and precipitation anomalies



Data used: EBAF ed2.8 and GPCP v2.2
Smoothed with a 12 month moving window
Surface sensible heat flux anomalies are not included

Conclusions

- EBAF Ed4.0 will incorporate the many algorithm improvements in the Edition4 CERES data products (calibration, clouds, ADMs, surface fluxes, time-interpolation, consistent ancillary inputs, etc.).
- The greatest changes will be for clear-sky TOA fluxes at high latitudes.
- Plan is to initially release 5 years (2005-2010) by early 2016.
- EBAF Ed2.8 will continue to be produced until EBAF Ed4.0 catches up.